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(54) **NETWORK DEVICE, CONTROL METHOD, AND STORAGE MEDIUM**

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H04L 41/0604 (2022.01)
H04L 43/0811 (2022.01)

(52) **U.S. Cl.**
CPC ***H04L 41/0613*** (2013.01); ***H04L 43/0811*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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(57) **ABSTRACT**

A network device that is connectable to a network includes processing circuitry. The processing circuitry is configured to execute detection processing including detection of connection availability for a plurality of different types of connections to the network, and generate a detection code indicating a detection result of the plurality of different types of connections to the network in responding to the detection processing.

17 Claims, 8 Drawing Sheets

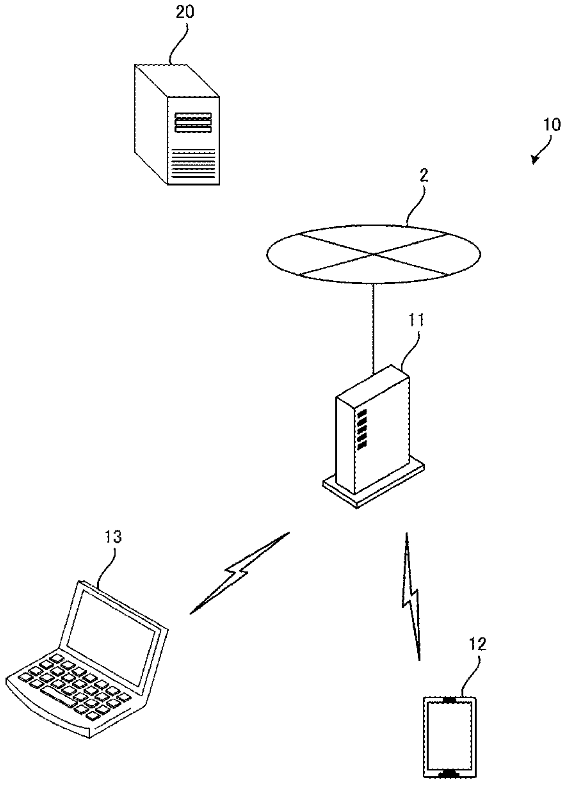


FIG. 1

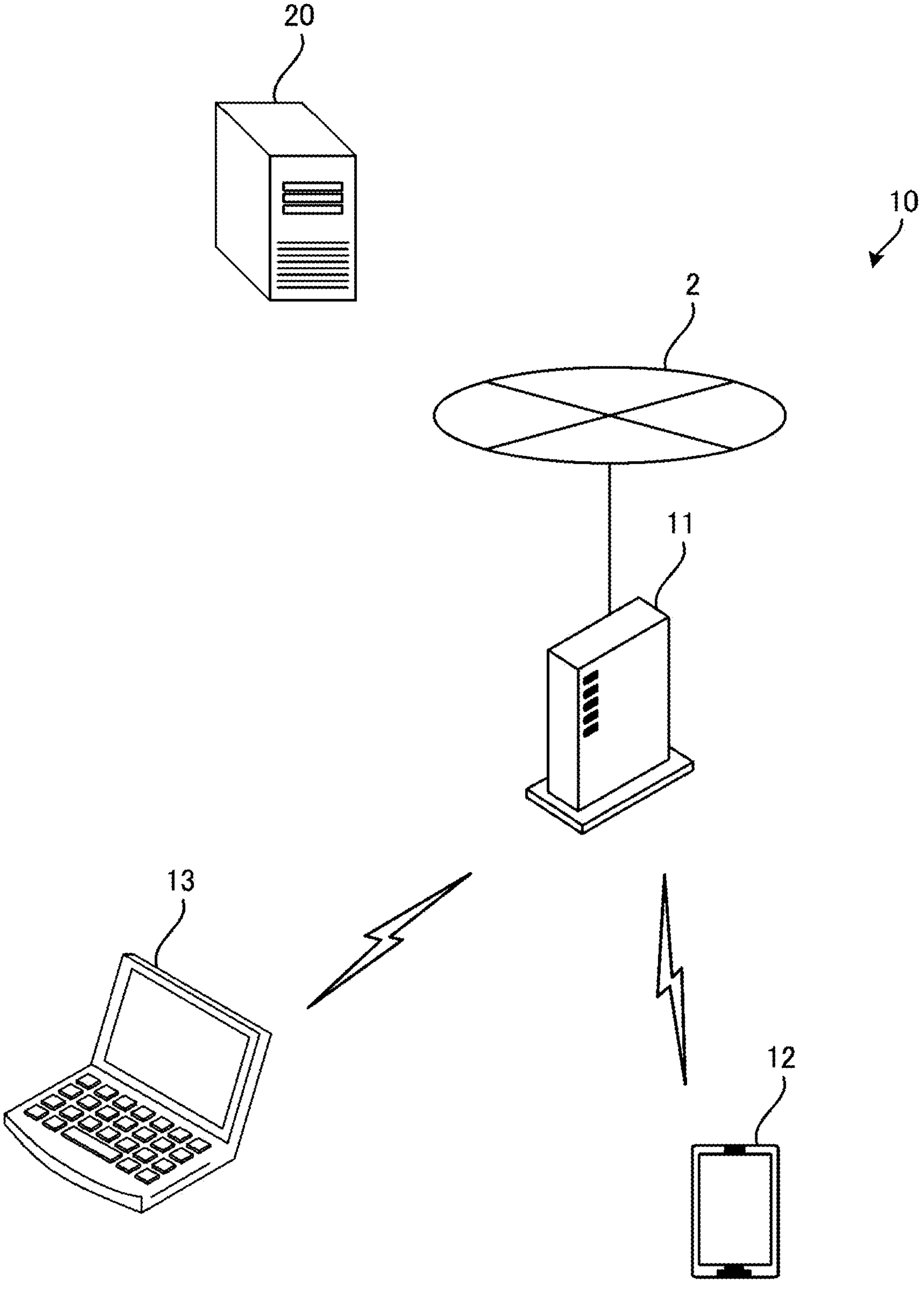


FIG. 2

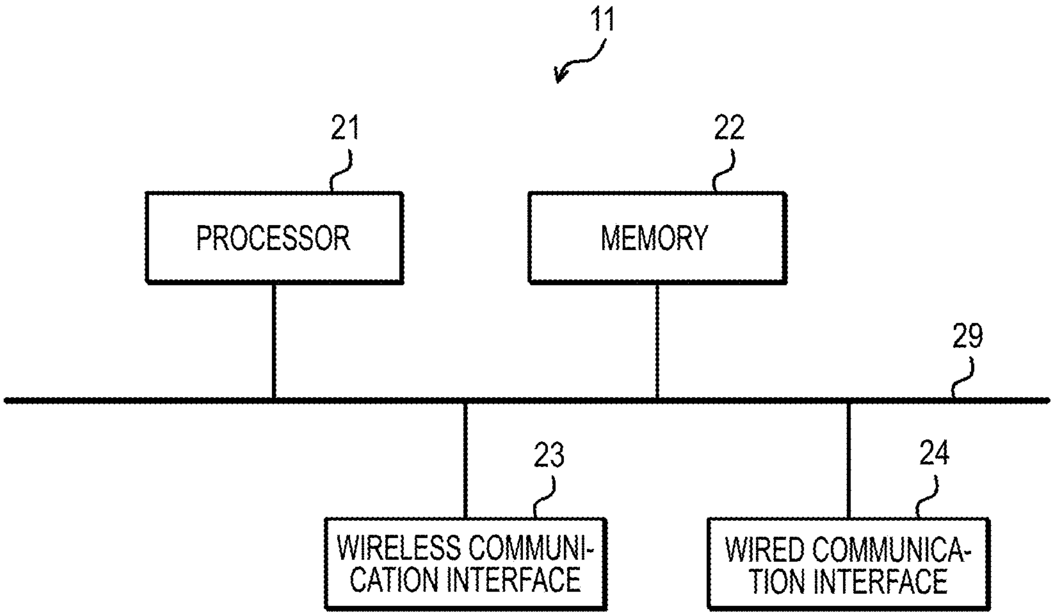

11
21
PROCESSOR
22
MEMORY
29
23
WIRELESS COMMUNICATION INTERFACE
24
WIRED COMMUNICATION INTERFACE

FIG. 3

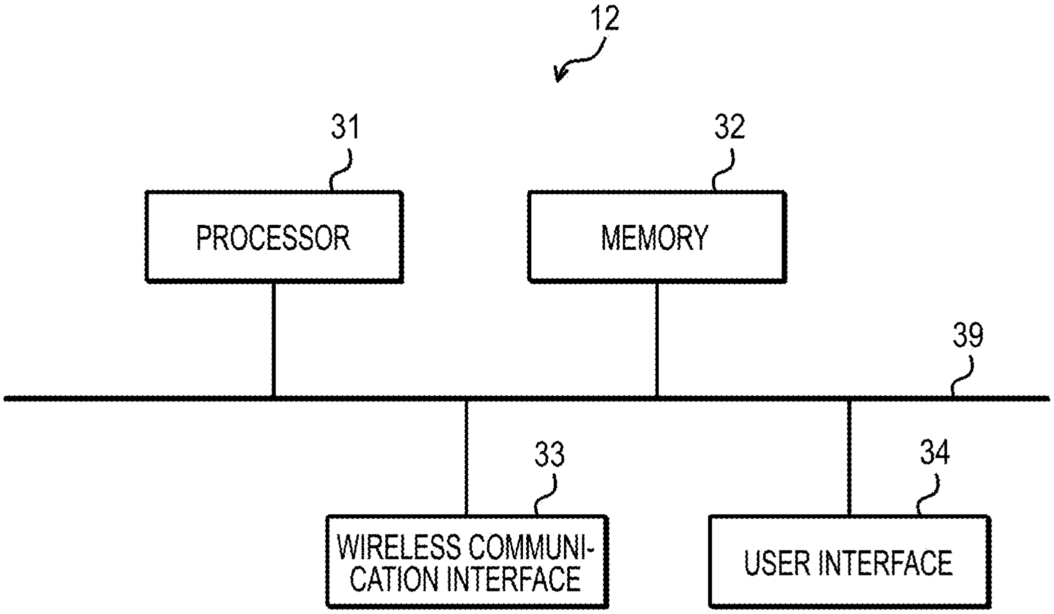

12
31
PROCESSOR
32
MEMORY
39
33
WIRELESS COMMUNICATION INTERFACE
34
USER INTERFACE

FIG. 4

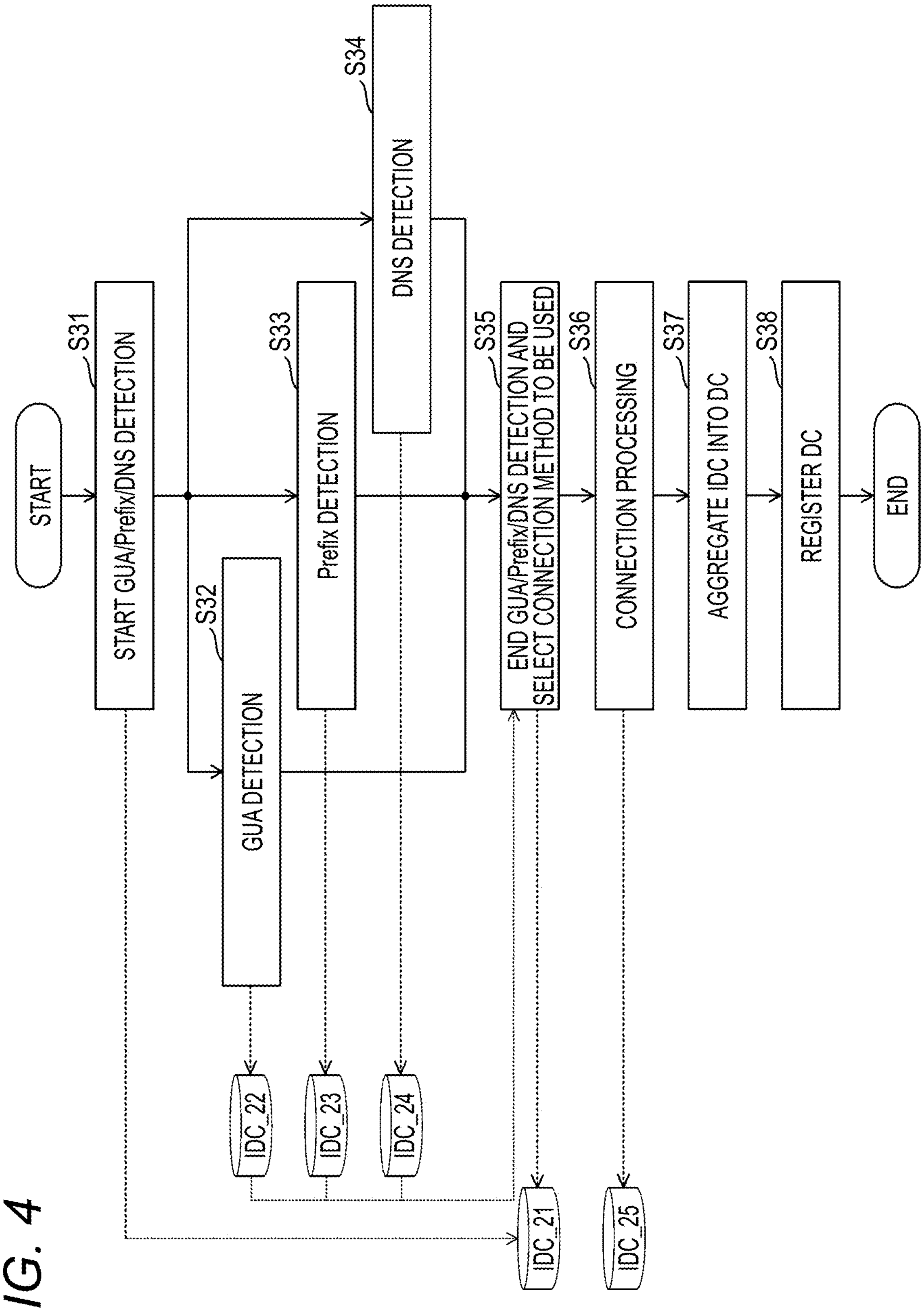

START
S31
START GUA/Prefix/DNS DETECTION
S32
GUA DETECTION
S33
Prefix DETECTION
S34
DNS DETECTION
S35
END GUA/Prefix/DNS DETECTION AND SELECT CONNECTION METHOD TO BE USED
S36
CONNECTION PROCESSING
S37
AGGREGATE IDC INTO DC
S38
REGISTER DC
END
IDC_22
IDC_23
IDC_24
IDC_21
IDC_25

FIG. 5

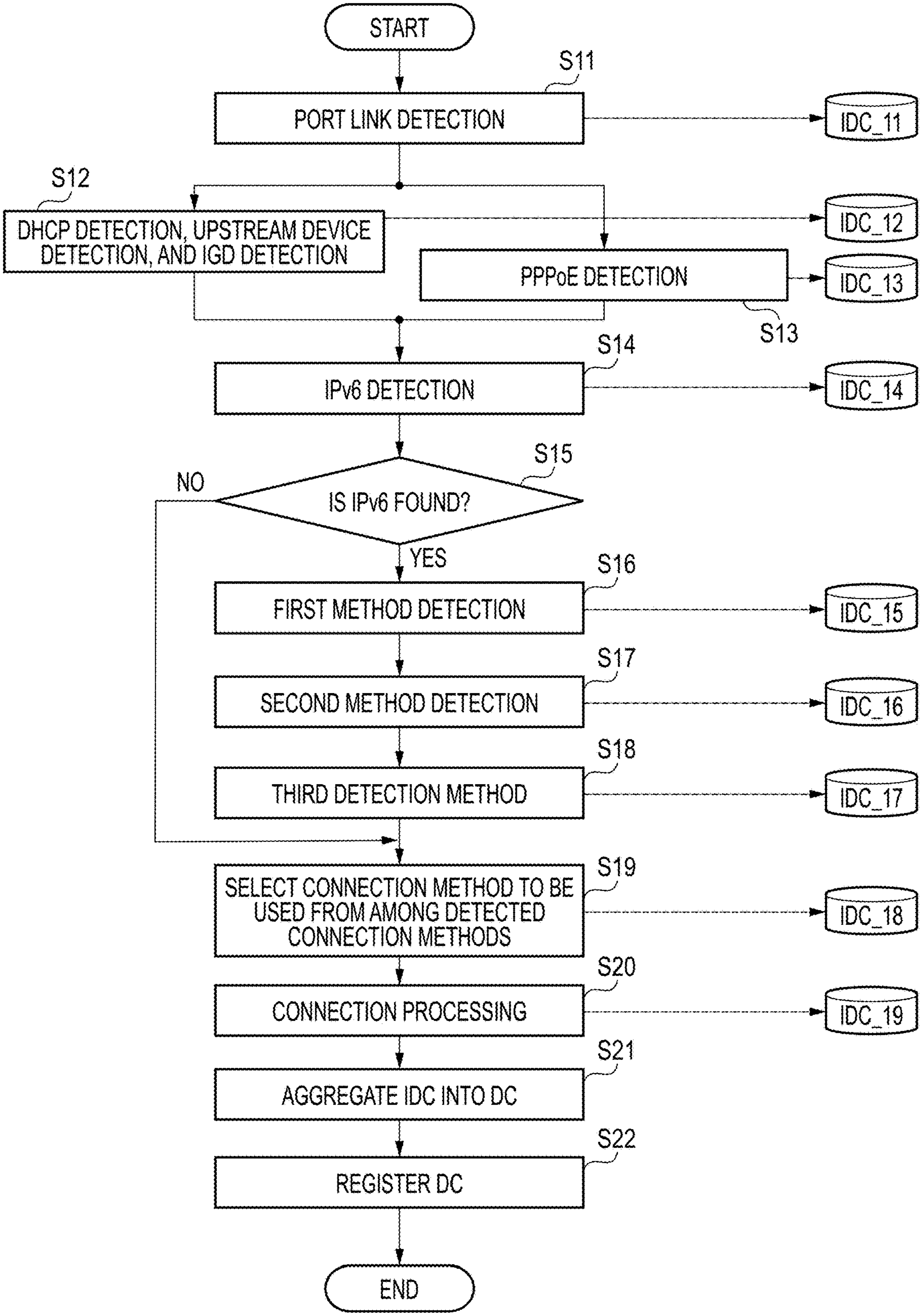

START
S11
PORT LINK DETECTION
IDC_11
S12
DHCP DETECTION, UPSTREAM DEVICE DETECTION, AND IGD DETECTION
IDC_12
PPPoE DETECTION
IDC_13
S13
S14
IPv6 DETECTION
IDC_14
S15
NO
IS IPv6 FOUND?
YES
S16
FIRST METHOD DETECTION
IDC_15
S17
SECOND METHOD DETECTION
IDC_16
S18
THIRD DETECTION METHOD
IDC_17
S19
SELECT CONNECTION METHOD TO BE USED FROM AMONG DETECTED CONNECTION METHODS
IDC_18
S20
CONNECTION PROCESSING
IDC_19
S21
AGGREGATE IDC INTO DC
S22
REGISTER DC
END

FIG. 6

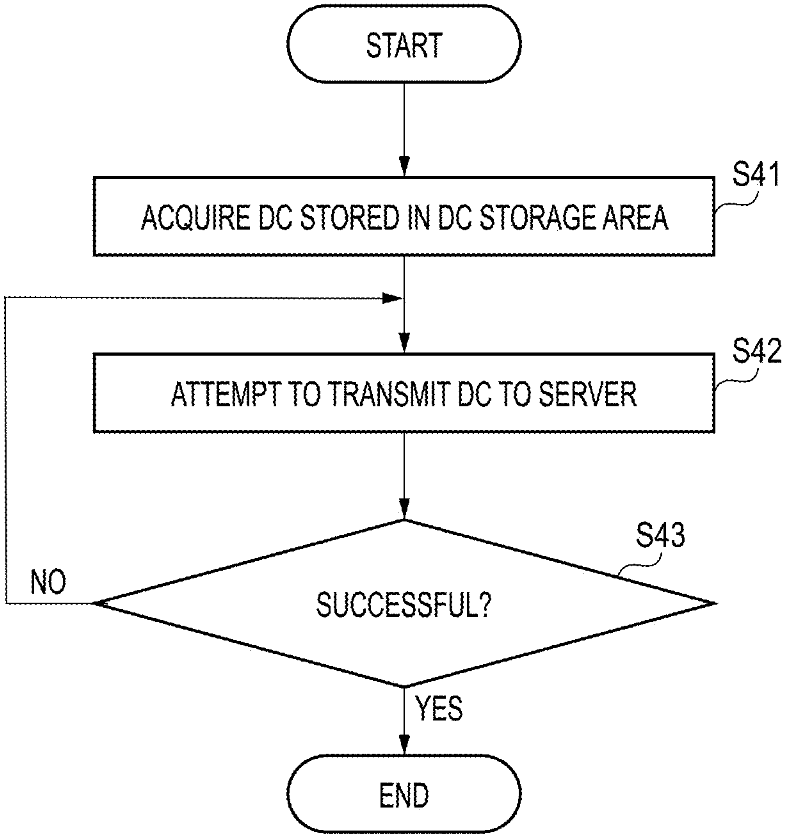

START
ACQUIRE DC STORED IN DC STORAGE AREA
S41
ATTEMPT TO TRANSMIT DC TO SERVER
S42
SUCCESSFUL?
S43
NO
YES
END

FIG. 7

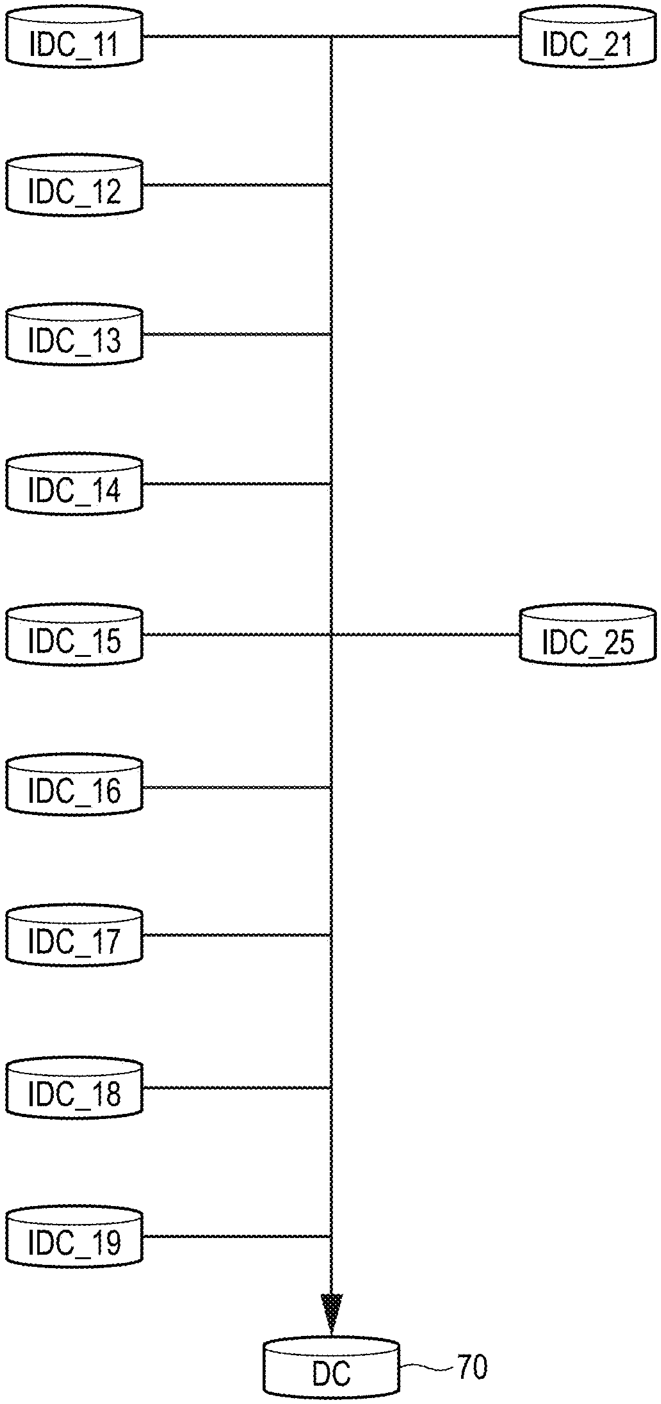
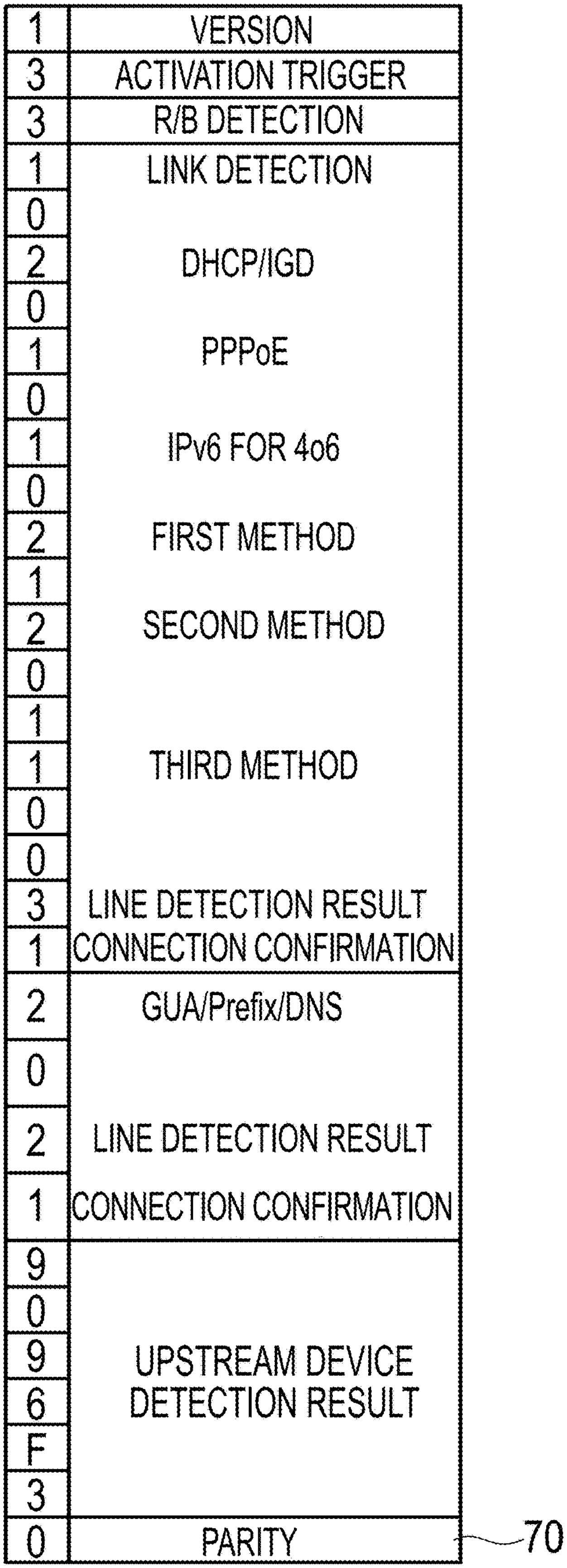
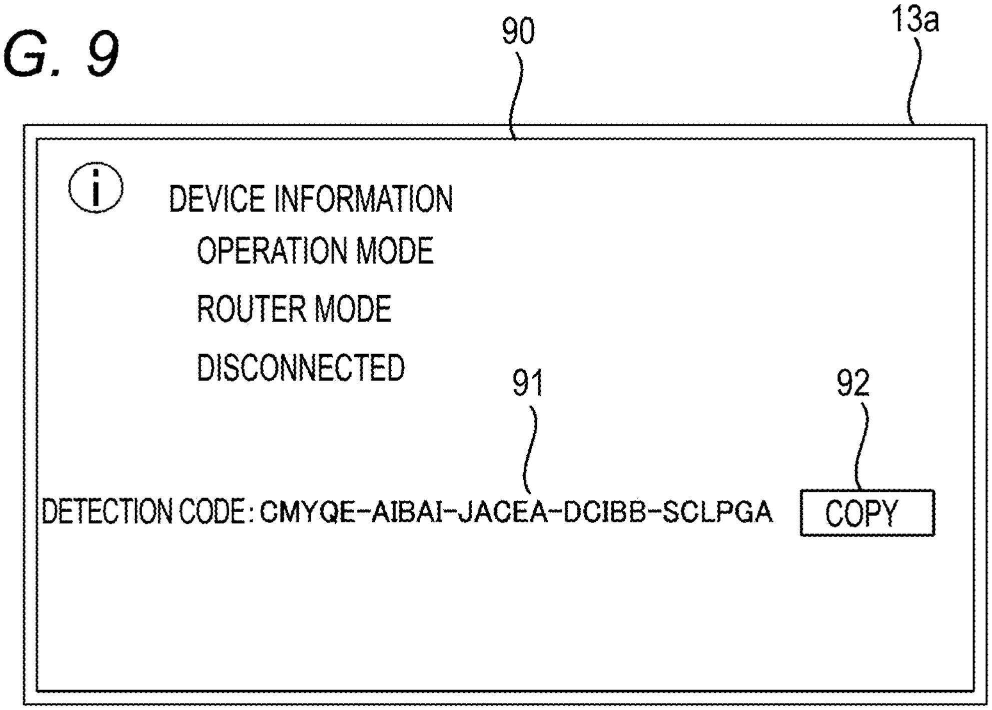

IDC_11
IDC_21
IDC_12
IDC_13
IDC_14
IDC_15
IDC_25
IDC_16
IDC_17
IDC_18
IDC_19
DC
70

FIG. 8



1	VERSION
3	ACTIVATION TRIGGER
3	R/B DETECTION
1	LINK DETECTION
0	
2	DHCP/IGD
0	
1	PPPoE
0	
1	IPv6 FOR 4o6
0	
2	FIRST METHOD
1	
2	SECOND METHOD
0	
1	
1	THIRD METHOD
0	
0	
3	LINE DETECTION RESULT
1	CONNECTION CONFIRMATION
2	GUA/Prefix/DNS
0	
2	LINE DETECTION RESULT
1	CONNECTION CONFIRMATION
9	UPSTREAM DEVICE DETECTION RESULT
0	
9	
6	
F	
3	
0	PARITY

FIG. 9



DEVICE INFORMATION

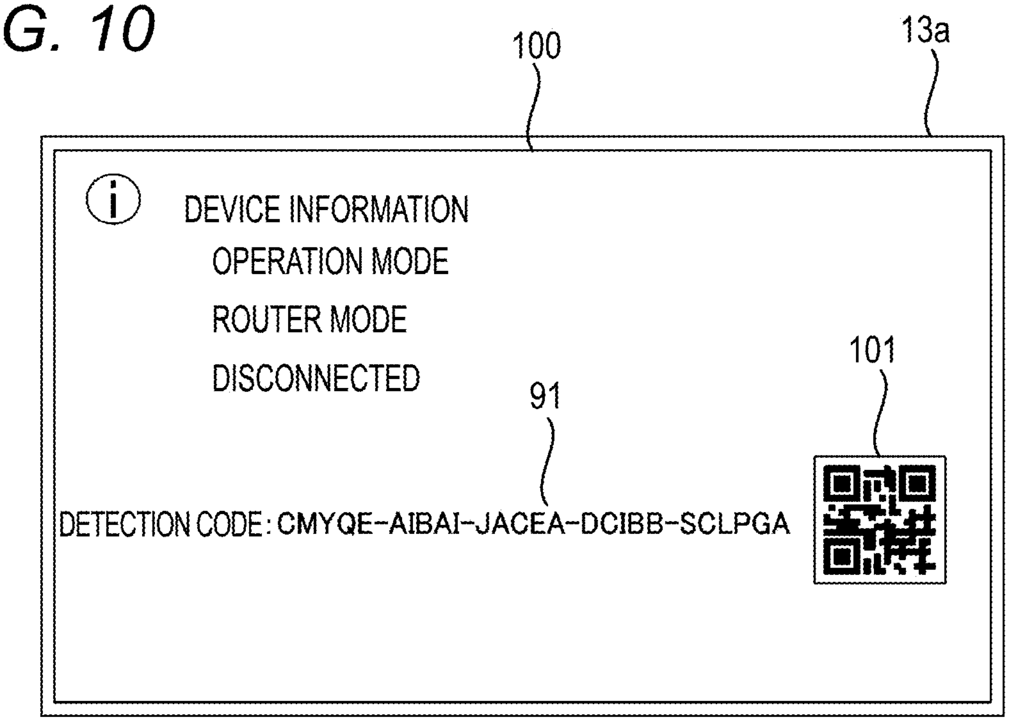
OPERATION MODE

ROUTER MODE

DISCONNECTED

DETECTION CODE: CMYQE-AIBAI-JACEA-DCIBB-SCLPGA

FIG. 10



DEVICE INFORMATION

OPERATION MODE

ROUTER MODE

DISCONNECTED

DETECTION CODE: CMYQE-AIBAI-JACEA-DCIBB-SCLPGA

NETWORK DEVICE, CONTROL METHOD, AND STORAGE MEDIUM

CROSS-REFERENCE TO RELATED APPLICATION

This application is based on and claims priority under 35 USC 119 from Japanese Patent Application No. 2022-134660 filed on Aug. 26, 2022, the entire content of which is incorporated herein by reference.

TECHNICAL FIELD

The present disclosure relates to a network device, a control method, and a storage medium.

BACKGROUND

A router having a function of searching for a line type on the Internet side and automatically executing settings until connection to the Internet is completed has been known (see, for example, “Keep this in mind! Broadband terminology points Wireless LAN routers Vol. 25: Internet line automatic detection function”, Broadband Watch, [online], [searched on Aug. 23, 2020], Internet <URL: https://bb.watch.impress.co.jp/cda/koko_osa/20038.html>).

SUMMARY

According to an aspect of the present disclosure, there is provided a network device that is connectable to a network, the network device including: processing circuitry configured to execute detection processing including detection of connection availability for a plurality of different types of connections to the network, and generate a detection code indicating a detection result of the plurality of different types of connections to the network in responding to the detection processing.

According to another aspect of the present disclosure, there is provided a control method for a network device connectable to a network, including: executing, by processing circuitry of the network device, detection processing including detection of connection availability for a plurality of different types of connections to the network; and generating, by the processing circuitry of the network device, a detection code indicating a detection result for the plurality of different types of connections to the network in responding to the detection processing.

According to another aspect of the present disclosure, there is provided a non-transitory computer-readable storage medium storing a control program to cause a processor of a network device connectable to a network to execute a process, the process including: executing detection processing including detection of connection availability for a plurality of different types of connections to the network; and generating a detection code indicating a detection result for the plurality of different types of connections to the network in responding to the detection processing.

BRIEF DESCRIPTION OF DRAWINGS

Exemplary embodiment(s) of the present disclosure will be described in detail based on the following figures, wherein:

FIG. **1** is a diagram showing an example of a wireless communication system to which a network device of the present disclosure is applied;

FIG. **2** is a diagram showing an example of a hardware configuration of a router;

FIG. **3** is a diagram showing an example of a hardware configuration of a user terminal;

FIG. **4** is a flowchart showing an example of IPv6 line connection processing by a processor of the router;

FIG. **5** is a flowchart showing an example of IPv4 line connection processing by the processor of the router;

FIG. **6** is a flowchart showing an example of transmission processing of a detection code by the processor of the router;

FIG. **7** is a diagram showing an example of aggregating a plurality of IDCs into a detection code (DC);

FIG. **8** is a diagram showing an example of a data structure of the DC;

FIG. **9** is a diagram showing an example of display of the DC; and

FIG. **10** is a diagram showing a modification example of the display of the DC.

DETAILED DESCRIPTION

Sometimes, even a router with a function of searching for a line type on the Internet side and automatically executing settings until connection to the Internet is completed may fail to connect to the Internet. In this case, it is difficult for a user of the router to describe a reason for failure to an inquiry destination such as a manufacturer. If the inquiry destination cannot obtain the reason for the failure, a state and an installation environment of the router cannot be reproduced, and information (logs) regarding the state and the installation environment of the router at the time of the communication failure are not obtained, and thus it is difficult to perform an investigation for improvement or the like.

The present disclosure is made in view of the above circumstances, and an object of the present disclosure is to efficiently provide information on a communication failure.

Hereinafter, embodiments of the present disclosure will be described with reference to the drawings.

(Wireless Communication System to which Network Device of the Present Disclosure is Applied)

FIG. **1** is a diagram showing an example of a wireless communication system to which a network device of the present disclosure is applied. A wireless communication system **10** shown in FIG. **1** includes, for example, a router **11** and user terminals **12** and **13**.

The router **11** is an example of the network device of the present disclosure. The router **11** has a router function of relaying communication between a network **2** and a communication device (for example, the user terminals **12** and **13**) connected to the router **11**. The network **2** is, for example, a wide area network (WAN) such as the Internet, and is connectable after connection methods are detected. Here, the connection methods correspond to the different types of connections to the network.

The router **11** is a so-called wireless local area network (LAN) router that functions as a wireless LAN access point that forms a wireless LAN. The router **11** may further have a function such as a switching hub.

The user terminals **12** and **13** are communication devices having a function of performing wireless communication with the router **11** by connecting to the wireless LAN formed by the router **11**. In the example shown in FIG. **1**, the user terminal **12** is a smartphone, and the user terminal **13** is a notebook personal computer.

A server **20** is connected to the network **2**. The server **20** is, for example, a server that collects a log of a router (for example, the router **11**) connected to the network **2**, and is, for example, a server managed by a manufacturer of the router **11**.

(Hardware Configuration Example of Router **11**)

FIG. **2** is a diagram showing an example of a hardware configuration of the router **11**. The router **11** shown in FIG. **1** includes, for example, a processor **21**, a memory **22**, a wireless communication interface **23**, and a wired communication interface **24**. These components of the router **11** are connected to one another by, for example, a bus **29**.

The processor **21** is processing circuitry that executes signal processing, and is, for example, a central processing unit (CPU) that controls the entire router **11**. The processor **21** may be implemented by another digital circuit such as a field programmable gate array (FPGA) and a digital signal processor (DSP). The processor **21** may further be implemented by combining a plurality of digital circuits. The processor **21** is an example of the processing circuitry of the present disclosure.

The memory **22** includes a detection code (DC) storage area, which will be described later, and an interval detection code (IDC) storage area for temporarily storing an IDC, which will be described later, and includes, for example, a main memory and an auxiliary memory. The main memory is a random access memory (RAM). The main memory is used as a work area for the processor **21**. In the DC storage area, up to N DCs and a DC generation time may be stored. When the number of the stored DCs exceeds N, a new DC may be registered by overwriting a specific past DC, or a new DC may be registered by overwriting the oldest DC.

The auxiliary memory is a non-volatile memory such as a magnetic disk, a flash memory, or the like. Various programs for operating the router **11** are stored in the auxiliary memory. The programs stored in the auxiliary memory are loaded into the main memory and executed by the processor **21**.

The auxiliary memory may also include a portable memory removable from the router **11**. The portable memory may include a universal serial bus (USB) flash drive and a memory card such as a secure digital (SD) memory card, an external hard disk drive, or the like.

The wireless communication interface **23** is a communication interface that executes the wireless communication. The wireless communication interface **23** is controlled by the processor **21**. For example, the wireless communication interface **23** executes wireless LAN communication with the user terminals **12** and **13**.

The wired communication interface **24** is a communication interface that executes wired communication. The wired communication interface **24** is controlled by the processor **21**. For example, the wired communication interface **24** executes internet protocol (IP) communication with the network **2**. Furthermore, the wired communication interface **24** may execute wired LAN communication with a communication device connected to the router **11** in a wired manner.

(Hardware Configuration Example of User Terminal **12**)

FIG. **3** is a diagram showing an example of a hardware configuration of the user terminal **12**. The user terminal **12** shown in FIG. **3** includes, for example, a processor **31**, a memory **32**, a wireless communication interface **33**, and a user interface **34**. These components of the user terminal **12** are connected to one another by, for example, a bus **39**.

The processor **31**, the memory **32**, and the wireless communication interface **33** have the same configuration as the processor **21**, the memory **22**, and the wireless communication interface **23** shown in FIG. **2**, respectively.

The wireless communication interface **33** of the user terminal **12** executes the wireless LAN communication with the router **11**. The wireless communication interface **33** of the user terminal **12** may also include a wireless communication interface that executes cellular communication and connects to the network **2** via a mobile communication network.

The user interface **34** includes, for example, an input device that receives operation input from a user and an output device that outputs information to the user. The input device may be realized by, for example, a key (for example, a keyboard) and a remote control. The output device may be realized by, for example, a display or a speaker. Both the input device and the output device may be realized by a touch panel or the like. The user interface **34** is controlled by the processor **31**. The user terminal **12** may not include the user interface **34**.

The user terminal **12** may include a wired communication interface that executes the wired LAN communication with the router **11**.

The hardware configuration of the user terminal **12** has been described, and the same applies to a hardware configuration of the user terminal **13**.

(IPv6 Line Connection Processing by Processor **21** of Router **11**)

FIG. **4** is a flowchart showing an example of IPv6 line connection processing by the processor **21** of the router **11**, which is executed in parallel with IPv4 line connection processing by the processor **21** of the router **11** described with reference to FIG. **5**. The processor **21** of the router **11** executes, for example, line connection processing shown in FIG. **4** for connection to the network **2** by IPv6.

First, the processor **21** executes GUA/Prefix/DNS detection for detecting whether a plurality of connection methods (GUA, Prefix, DNS) for connecting with IPv6 can be used (step S**31**). In step S**31**, for example, the processor **21** executes processing for starting the GUA detection, the Prefix detection, and the DNS detection in parallel. The processor **21** also generates IDC_**21** indicating a result of the processing for starting the GUA/Prefix/DNS detection in step S**31**.

Next, the processor **21** executes steps S**32** to S**34** in parallel. In step S**32**, the processor **21** executes the GUA detection to detect whether a global unique address (GUA) can be used in the connection to the network **2** (step S**32**). The processor **21** also generates IDC_**22** indicating a detection result of the GUA detection in step S**32**.

In step S**33**, the processor **21** executes Prefix detection to detect whether Prefix can be used in the connection to the network **2** (step S**33**). The processor **21** also generates IDC_**23** indicating a detection result of the Prefix detection in step S**33**.

In step S**34**, the processor **21** executes the DNS detection to detect whether a domain name system (DNS) can be used in the connection to the network **2** (step S**34**). The processor **21** also generates IDC_**24** indicating a detection result of the DNS detection in step S**34**.

The above processing is an example of the detection processing including detection of connection availability to the network **2** for each of a plurality of connection methods. The plurality of connection methods include, for example, GUA, Prefix, and DNS.

Next, the processor **21** ends the GUA/Prefix/DNS detection in steps S**32** to S**34** and selects a connection method to be used from among the connection methods detected as a useable connection method in the connection to the network **2** in steps S**32** to S**34** (step S**35**). The processor **21** also generates IDC_**21** indicating a selection result of the connection method in step S**35**. At this time, the processor **21** aggregates the IDC_**22**, the IDC_**23**, and the IDC_**24** generated in steps S**32** to S**34** into the IDC_**21**.

Next, the processor **21** executes the connection processing to the network **2** according to the selected connection method (step S3**6**). The processor **21** also generates IDC_**25** indicating a result of the connection processing to the network **2** in step S**35**.

Next, the processor **21** generates a DC in which each IDC is collected (step S**37**) as shown in FIG. **7**, and registers the DC generated in step S**37** in the DC storage area (step S**38**).

(IPv4 Line Connection Processing by Processor **21** of Router **11**)

FIG. **5** is a flowchart showing an example of IPv4 line connection processing by the processor **21** of the router **11**. The processor **21** of the router **11** executes, for example, line connection processing shown in FIG. **5** for the connection to the network **2** by Internet Protocol version 4 (IPv4).

First, the processor **21** executes port link detection to detect whether there is a port link connectable to the network **2** (step S**11**). The processor **21** also generates IDC_**11** indicating a detection result of the port link detection in step S**11**. The interval detection code (IDC) indicates a processing result of one interval in the line connection processing. The processing result includes, for example, whether the detection of various methods is started, whether the detection is completed, and a type of the detection result.

Next, the processor **21** executes steps S**12** and S**13** in parallel. In step S**12**, the processor **21** executes Dynamic Host Configuration Protocol (DHCP) detection, Internet Gateway Device (IGD) detection, and upstream device detection to detect whether DHCP can be used in the connection to the network **2** (step S**12**). The processor **21** also generates IDC_**12** indicating a detection result of the DHCP detection, IGD detection, and the upstream device detection in step S**12**. The detection may be only DHCP detection or only IGD detection.

In step S**13**, the processor **21** executes Point-to-Point Protocol over Ethernet (PPPoE) detection to detect whether PPPoE can be used in the connection to the network **2** (step S**13**). Ethernet is a registered trademark. The processor **21** also generates IDC_**13** indicating a detection result of the PPPoE detection in step S**13**.

Next, the processor **21** executes Internet Protocol version 6 (IPv6) detection to detect whether IPv6 can be used in the connection to the network **2** (step S**14**). For example, the processor **21** executes IPv6 detection in step S**14** by referring to the result of the IPv6 line connection processing shown in FIG. **4**, which is executed in parallel with the IPv4 line connection processing shown in FIG. **5**. The processor **21** also generates IDC_**14** indicating a detection result of the IPv6 detection in step S**14**.

Next, the processor **21** determines whether the connection to the network **2** with IPv6 is possible based on the result of step S**14** (step S**15**). When the connection to the network **2** with IPv6 is not possible (step S**15**: No), the processor **21** proceeds to step S**19**. When the connection to the network **2** with IPv6 is possible (step S**15**: Yes), the processor **21** determines availability of a plurality of connection methods for IPv4 connection using an IPv6 network.

That is, first, the processor **21** executes first method detection to determine whether a first method can be used (step S**16**). The processor **21** also generates IDC_**15** indicating a detection result of the first method detection in step S**16**.

Next, the processor **21** executes second method detection to determine whether second method can be used (step S**17**). The processor **21** also generates IDC_**16** indicating a detection result of the second method detection in step S**17**.

Next, the processor **21** executes third method detection to determine whether a third method can be used (step S**18**). The processor **21** also generates IDC_**17** indicating a detection result of the third method detection in step S**18**.

The first method, the second method, and the third method are all called IPv4 over IPv6 as connection methods for connecting with IPv4 using the IPv6 network. Such connection methods include, for example, Mapping of Addresses and Ports with Encapsulation (MAP-E), Dual-Stack Lite (DS-Lite), IP over IP (IPIP) Tunnel, Mapping of Address and Port Translation (MAP-T), and 464×lat.

The above processing is an example of the detection processing including detection of connection availability to the network **2** for each of a plurality of connection methods. The plurality of connection methods include, for example, DHCP, PPPoE, and IPv4 over IPv6.

Next, the processor **21** selects a connection method to be used from among the connection methods detected as the available connection method for the connection to the network **2** (step S**19**). For example, the processor **21** acquires priority information indicating a priority of each connection method and preferentially selects, based on the acquired priority information, the connection method to be used from among the usable connection methods as the connection method having a higher priority. The priority information is stored in, for example, the memory **22** of the processor **21**. The processor **21** also generates IDC_**18** indicating a selection result of the connection method in step S**19**. The priority information may be stored in a server, and the processor **21** may acquire the priority information from the server.

Next, the processor **21** executes the connection processing to the network **2** with the connection method selected in step S**19** (step S**20**). The processor **21** also generates IDC_**19** indicating a result of the connection processing to the network **2** in step S**20**.

Next, in step S**21**, the processor **21** collects the IDC_**11** to the IDC_**19** generated in IPv4 line connection processing and the IDC_**21** and the IDC_**25** generated in IPv6 line connection processing shown in FIG. **4** as shown in FIG. **7**, and aggregates these IDCs into the detection code DC.

Next, in step S**22**, the processor **21** registers the DC generated in step S**21** in the DC storage area.

When storing of the IDCs in the memory **22** in steps S**12** and S**13**, which are executed in parallel, occurs at the same time, performance degradation of the line connection processing or the likes may be caused. Therefore, storage processing of the IDC in steps S**12** and S**13** may be executed cooperatively by another processing separated from the detection in steps S**12** and S**13**.

(Transmission Processing of Detection Code by Processor **21** of Router **11**)

FIG. **6** is a flowchart showing an example of transmission processing of the detection code by the processor **21** of the router **11**. For example, after executing the connection processing of step S**20** shown in FIG. **5** and the connection processing of step S**36** shown in FIG. **4**, the processor **21** executes transmission processing of the detection code (DC) shown in FIG. **6**.

First, when an un-transmitted DC is stored in the DC storage area of the memory **22**, the processor **21** acquires the DC (step S**41**).

Next, the processor **21** attempts to transmit the DC to the server **20** connected to the network **2** (step S**42**). For example, the processor **21** attempts to transmit N DCs registered in the DC storage area. The DC transmission is attempted by the wired communication interface **24** via the network **2** connected by, for example, the connection processing of step S**20** shown in FIG. **5** or the connection processing of step S**36** shown in FIG. **4**.

Next, the processor **21** determines whether the DC transmission in step S**44** is successful (step S**43**). When the DC transmission is not successful (step S**43**: No), the processor **21** returns to step S**42** and attempts the DC transmission again.

In step S**43**, when the DC transmission is successful (step S**43**: Yes), the processor **21** ends the series of processing.

According to the transmission processing shown in FIG. **6**, the processor **21** may collectively transmit up to N DCs generated until that time point to the server **20**. While the case where the transmission processing shown in FIG. **6** is executed in response to the connection processing of step S**20** shown in FIG. **5** or the connection processing of step S**36** shown in FIG. **4** has been described, the processor **21** may execute the transmission processing shown in FIG. **6** periodically or in response to an instruction from the user.

For example, it is assumed that, after the connection of the router **11** to the network **2** by the line connection processing shown in FIGS. **4** and **5** fails, the user selects a connection method by manual setting and the connection of the router **11** to the network **2** is successful. In this case, up to N DCs which include a DC when the connection fails and which are stored in the DC storage area are transmitted to the server **20** via the network **2**. As a result, in the server **20**, it is possible to easily execute an investigation for improvement or the like of an algorithm of the line connection processing shown in FIGS. **4** and **5**. For example, by collecting the same DCs from a plurality of routers including the router **11**, when connection for each internet service provider (ISP) fails, it becomes possible to execute analysis such as a tendency when the connection is restored.

Further, in the DCs generated in responding to the line connection processing shown in FIG. **5**, in a case where, due to an influence of one detection of the steps S**12** and S**13** executed in parallel, the other detection of the steps S**12** and S**13** is interrupted, success or failure such as failure should be set in the IDC_**13** in a case where the other interrupted detection is handled. In a case where the other interrupted detection is not be handled, the IDC_**12** should be set. Therefore, based on the IDC_**13**, it is possible to analyze the situation when the connection by the line connection processing fails.

Furthermore, in the DCs generated in responding to the line connection processing shown in FIG. **5**, if the IDC_**15** to the IDC_**17** are pieces of information indicating "unexecuted" or the like, it may be inferred that steps S**16** to S**18** are skipped.

(Aggregation of Plurality of IDCs into Detection Code)

FIG. **7** is a diagram showing an example of aggregating a plurality of IDCs into a DC (detection code). The IDC_**11** to the IDC_**19** are IDCs generated in the IPv4 line connection processing shown in FIG. **5**. The IDC_**21** and the IDC_**25** are IDCs generated in the IPv6 line connection processing shown in FIG. **4**.

Among the IDC_**11** to the IDC_**19**, the IDC_**21**, and the IDC_**25**, IDCs related to connection method detection (for example, the IDC_**12** to the IDC_**17** and the IDC_**22** to the IDC_**24**) include information on the connection availability to the network **2** with that connection method and an error type (such as at which stage a failure occurs) in a case where the connection to network **2** is not available with that connection method.

The processor **21** generates a DC **70** storing each value of the IDC_**11** to the IDC_**19**, the IDC_**21**, and the IDC_**25** in a predetermined format. As a result, the DC (detection code) **70** is generated in which the IDC_**11** to the IDC_**19**, the IDC_**21**, and the IDC_**25** are aggregated. The predetermined format may be, for example, a format in which a predetermined order is determined, or may be a set of result information obtained by assigning a specific code to each connection method. Specifically, the predetermined format includes a type length value (TLV) format and a key value format.

(Data Structure of Detection Code)

FIG. **8** is a diagram showing an example of a data structure of the DC (detection code) **70**. As shown in FIG. **8**, the DC **70** is, for example, a 32-digit hexadecimal code ("13310201010212011003120219096F30").

In the example shown in FIG. **8**, the fourth to fifth digits (link detection) of the DC **70** are values of the IDC_**11** indicating the result of the port link detection in step S**11** shown in FIG. **5**.

The sixth to seventh digits (DHCP) of the DC **70** are values of the IDC_**12** indicating the results of the DHCP detection and the IGD detection in step S**12** shown in FIG. **5**.

The eighth to ninth digits (PPPoE) of the DC **70** are values of the IDC_**13** indicating the result of the PPPoE detection in step S**13** shown in FIG. **5**.

The tenth to eleventh digits (IPv6 for 4o6) of the DC **70** are values of the IDC_**14** indicating the result of IPv6 detection in step S**14** shown in FIG. **5**.

The twelfth to thirteenth digits (first method) of the DC **70** are values of the IDC_**15** indicating the result of the first method detection in step S**16** shown in FIG. **5**.

The fourteenth to sixteenth digits (second method) of the DC **70** are values of the IDC_**16** indicating the result of the second method detection in step S**17** shown in FIG. **5**.

The seventeenth to nineteenth digits (third method) of the DC **70** are values of the IDC_**17** indicating the result of the third method detection in step S**18** shown in FIG. **5**.

The twentieth digit (selection result of the connection method) of DC**70** is a value of the IDC_**18** of a connection processing result indicating the selection result of the connection method in step S**19** shown in FIG. **5**.

The 21st digit (connection confirmation) of the DC **70** is a value of the IDC_**19** indicating the result of the connection processing in step S**20** shown in FIG. **5**.

The 22nd to 23rd digits (GUA/Prefix/DNS) of the DC **70** are values of the IDC_**21** (including a result of merging the IDC_**22** to the IDC_**24**) indicating the result of detection by steps S**31** to S**34** shown in FIG. **4**.

The 24th to 25th digits (the selection result of the connection method and the connection processing result) of the DC **70** are values of the IDC_**25** indicating the results of the selection of the connection method and the connection processing in step S**36** shown in FIG. **4**.

The DC **70** is described as an example of the detection code, and the detection code is not limited to the DC **70**. For example, for the DC **70**, an arrangement of each value and the number of assigned digits may be arbitrarily designed. The detection code may be a code obtained by encoding a code such as the DC **70**. This encoding method is a reversible transform method capable of restoring the DC **70** from the encoded code.

As an example, when "13310201010212011003120219096F30", which is the DC **70** shown in FIG. **8**, is encoded with, for example, an encoding method of a unique reversible transformation method, a code "CMYQE-AIBAI-JACEA-DCIBB-SCLPGA" may be obtained, which may be used as the detection code. In this case, in step S**43** shown in FIG. **6**, the processor **21** registers, in the DC storage area, a code obtained by encoding the DC instead of the DC.

In this way, the processor **21** executes the detection processing. The detection processing is processing (for example, steps S**12** to S**18** shown in FIG. **5** and steps S**32** to S**34** shown in FIG. **4**) including determination of the connection availability to the network **2** with each of the plurality of connection methods. The processor **21** executes the connection processing to the network **2** with the connection method selected based on the result of the detection processing. Each time executing the detection processing, the processor **21** generates a detection code (DC **70**) indicating the detection result for the plurality of connection methods obtained by the detection processing. As a result, it is possible to provide the detection code indicating the detection result of the plurality of connection methods to an entity (for example, the server **20**) that collects the detection code through the router **11** after connection to the network **2**, or by communication using a telephone or the like.

In the detection code, the detection result for the plurality of connection methods is shown in a predetermined format. Therefore, the entity that collects the detection code can easily analyze how the detection processing including the detection of the connection availability to the network **2** for each of the plurality of connection methods is executed.

(Display of Detection Code)

FIG. **9** is a diagram showing an example of display of the DC **70** (detection code). The processor **21** of the router **11** may execute control to cause the communication device connected to the router **11** to reproduce the DC **70**, which is the detection code, or information with which the DC **70** can be restored. For example, it is assumed that the user terminal **13** (notebook personal computer) shown in FIG. **1** is connected to the router **11** via a wired LAN or the wireless LAN.

In this case, in response to a request from the user terminal **13**, the processor **21** of the router **11** transmits a code **91** ("CMYQE-AIBAI-JACEA-DCIBB-SCLPGA"), which is information with which the DC **70** can be restored, to the user terminal **13** together with device information (operation mode and the like) of the processor **21**. The user terminal **13** displays an image **90** indicating information received from the router **11** by a display **13***a* of the user terminal **13**.

Accordingly, for example, when a communication failure in which the router **11** cannot be connected to the network **2** occurs, the user of the router **11** may easily transmit the code **91** to the inquiry destination such as a manufacturer when making an inquiry to the inquiry destination. For example, in the case in which an inquiry is made using a telephone, the code **91** shorter than the DC **70** by compression may be easily transmitted orally. Also, in the case when an inquiry is made by e-mail, chat, inquiry form, or the like by the user terminals **12** and **13** that can be connected to the network **2** in a path different from that of the router **11**, the code **91** shorter than the DC **70** by compression may be easily input and transmitted.

Therefore, even in a situation where the router **11** cannot transmit the DC to the server via the network **2**, it is possible to easily provide the DC **70** to the inquiry destination. Therefore, an appropriate response to the inquiry may be made at the inquiry destination, or an appropriate investigation for improvement of the algorithm of the line connection processing shown in FIGS. **4** and **5** may be executed. The network **2** described above refers to, for example, a WAN, and is a network that can be connected after the connection method is detected.

A copy button **92** may also be included. When the user of the user terminal **13** performs instruction operation on the copy button **92**, the code **91** is copied to a clipboard of an operating system (OS) of the user terminal **13**. As a result, the user may easily input the code **91** in an e-mail, a chat, an inquiry form, or the like by a paste operation.

While the control to cause the user terminal **13** to display the code **91** has been described, the processor **21** may execute control to cause a speaker of the user terminal **13** to output the code **91** by voice, for example.

In a case where a main body of the router is provided with either or both of a speaker and a liquid crystal monitor, the code **91** may be displayed and output from the speaker or the liquid crystal monitor of the router.

FIG. **10** is a diagram showing a modification of the display of the DC **70** (detection code). In response to the request from the user terminal **13**, the processor **21** of the router **11** may convert the first information including the code **91** ("CMYQE-AIBAI-JACEA-DCIBB-SCLPGA") into an optically readable two-dimensional code **101** in a format transmittable to the server **20** (specific transmission destination), and may transmit, in addition to the device information (operation mode and the like) of the processor **21**, the code **91** of the processor **21**, and the two-dimensional code **101**. The first information is, for example, a uniform resource identifier (URI) including the code **91** as a query following an address of the server **20**. The code **91** may include the URI or may not include the URI. The code **91** may also be electronically readable.

In this case, the user terminal **13** displays an image **100** including the device information, the code **91**, and the two-dimensional code **101** on the display **13***a*. On the other hand, for example, the user captures the two-dimensional code **101** using the user terminal **12** (smartphone). The user terminal **12** acquires the above URI (first information) from imaging data of the two-dimensional code **101** and accesses the acquired URI via, for example, a mobile communication network.

In addition, the user may capture the code **91** displayed on the user terminal **13** by a screenshot or the like using the user terminal **12**, and send the code **91** to a specific transmission destination.

Accordingly, even in a situation where the router **11** cannot be connected to the network **2**, the user may easily transmit the code **91** to the server **20** by capturing the two-dimensional code **101** using the user terminal **12** (smartphone) connectable to the mobile communication network.

While the example has been described in which the router **11** transmits the two-dimensional code **101** from which the first information (URI) is optically readable to the user terminal **13** with reference to the example shown in FIG. **10**, the router **11** may transmit the first information to the user terminal **13**. In this case, the user terminal **13** converts the first information received from the router **11** into the two-dimensional code **101** and displays the two-dimensional code **101**.

While the example in which the code **91** is a code in which the DC **70** is encoded has been described with reference to the examples shown in FIGS. **9** and **10**, the code **91** may be a DC **70** that is not encoded.

(Modification 1)

While the router **11** has been described as the network device, the network device is not limited to the router **11** and may be a network device that relays communication between the communication device and the network **2**.

(Modification 2)

While the transmission processing of collectively transmitting the most recent N DCs is described in FIG. **6**, the processor **21** may store the DC generated for each line connection processing shown in FIGS. **4** and **5** up to N for each state after the line connection processing. The processor **21** may collectively transmit the most recent N DCs for each state after the line connection processing. As a result, even in a case where the same error occurs N times or more in the line connection processing, for example, it is possible to prevent a situation in which logs related to the error of the previous line connection processing cannot be collected. As a state after the line connection processing (corresponding to the determined state), for example, any states such as "failure immediately before the initial connection succeeds after the initial startup", "the initial connection succeeds after the initial startup" and the likes can be set.

The determined state after the line connection processing may be identified by assigning a predetermined code to the DC. Alternatively, a table in which each determined state can be identified may be provided and the detection code DC may be stored therein for each determined state. These are stored in the DC storage area.

(Modification 3)

A configuration may be adopted in which a communication device that is remotely accessible to the router **11** has an initiative to acquire (PULL) the detection code (DC) from the router **11** in response to a request from the communication device. As a result, for example, a supporter different from the user may remotely access the router **11** of the user and confirm the detection code.

(Modification 4)

The router **11** may have the initiative to transmit (PUSH) the detection code to a specific terminal on a LAN side. Thereby, for example, a logging server on the LAN side or a dedicated management application (for example, an application of the user terminal **12** or the user terminal **13**) may collect the result code.

(Program)

Programs stored in a read only memory (ROM) of the memory **22** of the router **11** and programs stored in a ROM of the memory **32** of the user terminal **12** are stored in a non-transitory storage medium in which these programs can be read by a computer. The "computer-readable storage medium" is, for example, an optical medium such as a compact disc-ROM (CD-ROM) or a magnetic storage medium such as a USB memory or a memory card. Such a program can also be provided by downloading via a network.

As described above, the following matters are disclosed in the present specification.

(1) A network device that is connectable to a network, the network device including:

processing circuitry configured to

execute detection processing including detection of connection availability for a plurality of different types of connections to the network, and

generate a detection code indicating a detection result of the plurality of different types of connections to the network in responding to the detection processing.

(2) The network device according to (1), in which

the detection processing includes detection of connection availability in parallel for each of the plurality of different types of connections to the network.

(3) The network device according to (2), in which

the detection result includes an error type related to the connection to the network.

(4) The network device according to (1), in which

the detection code includes a portion in which the detection result of the plurality of different types of connections to the network is stored according to a predetermined format.

(5) The network device according to (1), in which

the processing circuitry is configured to transmit the detection code or information with which the detection code is restorable to a specific transmission destination via the network that is connectable by detecting a type of connection to the network from among the different types of connections to the network, in a state of being connected to the network.

(6) The network device according to (5), in which

the processing circuitry is configured to collect a predetermined number of the detection code or of pieces of the information with which the detection code is restorable and to transmit the detection code or the information to the specific transmission destination via the network that is connectable by detecting the type of connection to the network.

(7) The network device according to (1), in which

the processing circuitry is configured to notify a communication device connected to the network device of the detection code or information with which the detection code is restorable, not via the network that is connectable by detecting a type of connection to the network from among the different types of connections to the network.

(8) The network device according to (1), in which

the processing circuitry is configured to notify a communication device capable of remotely accessing the network of the detection code or information with which the detection code is restorable.

(9) The network device according to (1), in which

the detection code or information with which the detection code is restorable is acquired by a communication device capable of remotely accessing the network in response to a request from the communication device.

(10) The network device according to (1), in which

the processing circuitry is configured to notify a communication device connected to a network different from the network to which the network device is connectable of the detection code or information with which the detection code is restorable.

(11) The network device according to (1), further including:

a memory for storing the detection code.

(12) The network device according to (11), in which

the detection code is stored in the memory in association with a determined state.

(13) The network device according to (12), in which

the processing circuitry is configured to collect a predetermined number of the detection code or of pieces of information with which the detection code is restorable for each determined state and to transmit the detection code or the information to a specific transmission destination via the network that is connectable by detecting a type of connection to the network from among the different types of connections to the network.

(14) The network device according to (1), in which

the processing circuitry is configured to notify a communication device connected to the network device of the detection code or information with which the detection code is restorable, not via the network that is connectable by detecting a type of connection to the network from among the different types of connections to the network.

(15) The network device according to (1), in which

the processing circuitry is configured to select a type of connection to the network from among the different types of connections to the network to be used according to a predetermined priority based on the detection result of the plurality of different types of connections to the network.

(16) A control method for a network device connectable to a network, including:

executing, by processing circuitry of the network device, detection processing including detection of connection availability for a plurality of different types of connections to the network; and

generating, by the processing circuitry of the network device, a detection code indicating a detection result for the plurality of different types of connections to the network in responding to the detection processing.

(17) The control method of according to (16), in which

the detection processing includes detection of connection availability to the network.

(18) The control method of according to (17), in which

the detection result includes an error type related to the connection to the network.

(19) The control method according to (16), in which the detection code includes a

portion in which the detection result of the plurality of different types of connections to the network is stored according to a predetermined format.

(20) A non-transitory computer-readable storage medium storing a control program to cause a processor of a network device connectable to a network to execute a process, the process including:

executing detection processing including detection of connection availability for a plurality of different types of connections to the network; and

generating a detection code indicating a detection result for the plurality of different types of connections to the network in responding to the detection processing.

What is claimed is:

1. A network device that is connectable to a network, the network device comprising:

processing circuitry configured to

execute detection processing including detection of connection availability for a plurality of different types of connections to the network,

generate a detection code indicating a detection result of the plurality of different types of connections to the network in responding to the detection processing,

wherein the detection code includes a plurality of portions in which the detection result of each of the plurality of different types of connections to the network is stored in one of the plurality of portions according to a predetermined format,

wherein the detection code stores each value of an interval detection code (IDC) including IDCs related to connection method detection which includes information on the connection availability to the network with that connection method and an error type in a case where the connection the network is not available with that connection method, and

transmit the detection code or information with which the detection code is restorable to a specific transmission destination via the network that is connectable by detecting a type of connection to the network from among the different types of connections to the network, in a state of being connected to the network.

2. The network device according to claim 1, wherein

the detection processing includes detection of connection availability in parallel for each of the plurality of different types of connections to the network.

3. The network device according to claim 2, wherein

the detection result includes an error type related to the connection to the network.

4. The network device according to claim 1, further comprising:

a memory for storing the detection code.

5. The network device according to claim 4, wherein

the detection code is stored in the memory in association with a determined state.

6. The network device according to claim 5, wherein

the processing circuitry is configured to collect a predetermined number of the detection code or of pieces of information with which the detection code is restorable for each determined state and to transmit the detection code or the information to a specific transmission destination via the network that is connectable by detecting a type of connection to the network from among the different types of connections to the network.

7. The network device according to claim 1, wherein

the processing circuitry is configured to collect a predetermined number of the detection code or of pieces of the information with which the detection code is restorable and to transmit the detection code or the information to the specific transmission destination via the network that is connectable by detecting the type of connection to the network.

8. The network device according to claim 1, wherein

the processing circuitry is configured to notify a communication device connected to the network device of the detection code or information with which the detection code is restorable, not via the network that is connectable by detecting a type of connection to the network from among the different types of connections to the network.

9. The network device according to claim 1, wherein

the processing circuitry is configured to notify a communication device capable of remotely accessing the network of the detection code or information with which the detection code is restorable.

10. The network device according to claim 1, wherein

the detection code or information with which the detection code is restorable is acquired by a communication device capable of remotely accessing the network in response to a request from the communication device.

11. The network device according to claim 1, wherein

the processing circuitry is configured to notify a communication device connected to a network different from the network to which the network device is connectable of the detection code or information with which the detection code is restorable.

12. The network device according to claim 1, wherein

the processing circuitry is configured to notify a communication device connected to the network device of the detection code or information with which the detection code is restorable, not via the network that is connectable by detecting a type of connection to the network from among the different types of connections to the network.

13. The network device according to claim **1**, wherein

the processing circuitry is configured to select a type of connection to the network from among the different types of connections to the network to be used according to a predetermined priority based on the detection result of the plurality of different types of connections to the network.

14. The network device according to claim **1**, wherein the processing circuitry is configured to

store the detection code generated for each line connection processing up to N for each state after the line connection processing, and

collectively transmit the most recent N detection codes for each state after the line connection processing.

15. A control method for a network device connectable to a network, comprising:

executing, by processing circuitry of the network device, detection processing including detection of connection availability for a plurality of different types of connections to the network;

generating, by the processing circuitry of the network device, a detection code indicating a detection result for the plurality of different types of connections to the network in responding to the detection processing,

wherein the detection code includes a plurality of portions in which the detection result of each of the plurality of different types of connections to the network is stored in one of the plurality of portions according to a predetermined format,

wherein the detection code stores each value of an interval detection code (IDC) including IDCs related to connection method detection which includes information on the connection availability to the network with that connection method and an error type in a case where the connection the network is not available with that connection method; and

transmitting, by the processing circuitry of the network device, the detection code or information with which the detection code is restorable to a specific transmission destination via the network that is connectable by detecting a type of connection to the network from among the different types of connections to the network, in a state of being connected to the network.

16. The control method according to claim **15**, wherein

the detection processing includes detection of connection availability to the network.

17. A non-transitory computer-readable storage medium storing a control program to cause a processor of a network device connectable to a network to execute a process, the process comprising:

executing detection processing including detection of connection availability for a plurality of different types of connections to the network;

generating a detection code indicating a detection result for the plurality of different types of connections to the network in responding to the detection processing,

wherein the detection code includes a plurality of portions in which the detection result of each of the plurality of different types of connections to the network is stored in one of the plurality of portions according to a predetermined format,

wherein the detection code stores each value of an interval detection code (IDC) including IDCs related to connection method detection which includes information on the connection availability to the network with that connection method and an error type in a case where the connection the network is not available with that connection method; and

transmitting the detection code or information with which the detection code is restorable to a specific transmission destination via the network that is connectable by detecting a type of connection to the network from among the different types of connections to the network, in a state of being connected to the network.

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